



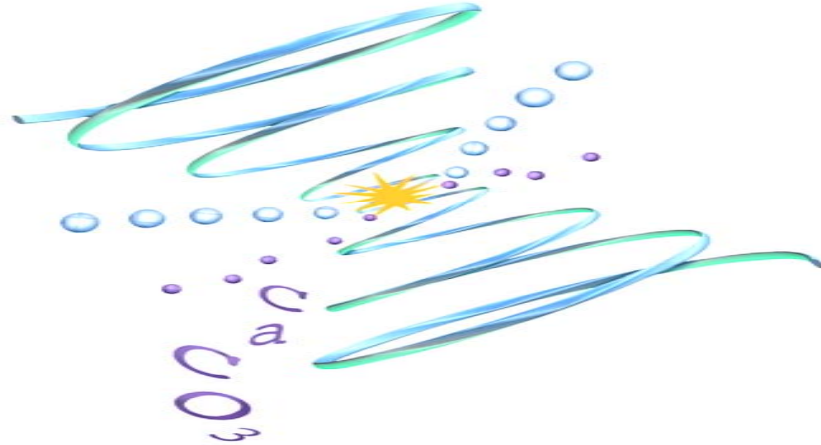
***Non-Chemical Water Treatment***

**Water Efficient Cooling Towers with  
VRTX Non-Chemical Water Treatment**

David L. Koontz  
Vice President  
VRTX Technologies  
800-722-0476

[vrtx@vrtxtech.com](mailto:vrtx@vrtxtech.com)

[www.vrtx-technologies.com](http://www.vrtx-technologies.com)



# **VRTX Technology**

- **Introduction of Technology**
- **Highlights of case histories on cooling water treatments**

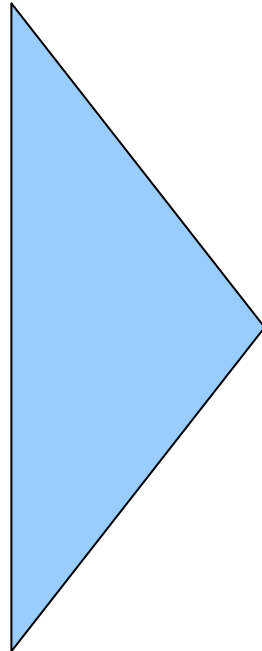
# Problems Related to Cooling Water Treatment

## PROBLEMS

**Scale**

**Corrosion**

**Bacteria**



## EFFECTS

- Increased maintenance cost
- Reduced heat transfer efficiency
- Increased energy cost
- Increased water costs
- Increased sewage costs
- Increased safety and training issues
- Reduced plant efficiency
- Reduced equipment life
- Growth of hazardous micro organisms

# **Conventional Chemical Solution**

- **No Water Treatment is perfect. Chemicals treatment is:**
  - **Expensive on a recurring basis**
  - **High labor and maintenance costs**
  - **Discharge harmful to the environment**
  - **High water and sewer costs**
- **Chemical treatment may not provide long- term, predictable control of scale, corrosion and microbiological contamination**

# **Conventional Chemical Solution**

- **Chemical solution requires constant adjustments, daily additions of chemicals and costly system blow-downs**
- **Chemical treatment costs range from \$750 to \$1,250 per month for 1,000 ton tower**
  - **Water is cycled only 2.0x to 3.0x before it is discharged (blow-down)**
  - **Blow-down is a major source of discharge streams and a source of pollution**
  - **Increased water and sewer costs**
- **Water and sewer costs are projected to increase by 10% to 40% per year**

# **VRTX Technology**

- Introduction to Non-Chemical Cooling  
Water Treatment

**Technical Paper #6**

**Non-Chemical Water Treatment  
for Evaporative Condensers**

**John Lane  
EVAPCO, Inc.  
Taneytown, Maryland**

**Abstract**

*Maintaining good water quality is one of the most difficult challenges to achieving optimum system efficiency and prolonging the life of an evaporative condenser. Evaporative condensers typically have a high evaporation rate and use a relatively small volume of water, making chemical water treatment difficult. Using non-chemical devices (NCDs) to treat water in industrial refrigeration plants has several potential benefits, including reduced water consumption and elimination of the regulatory headaches, safety risks, and potential equipment damage associated with handling chemicals. NCDs may also improve system operating efficiency, often for much less money than the lifecycle cost of chemical water treatment. These issues have prompted many end users to investigate and try non-chemical water treatment devices, with varying success.*

*2006 IIAR Ammonia Refrigeration Conference & Exhibition, Reno, Nevada*

# Non-Chems

## Several Technologies Marketed

- **Magnetic & Electromagnetic**
  - Magnatech, Superior, Triangular Wave
- **Electronic/AD Induced Electric Field Technologies**
  - ED 2000, Clearwater
- **Electrostatic**
  - Zeta Rod, Ion Stick
- **Electrolysis (Copper/Silver Ionization)**
  - Baker Hydro, Oxion, Liquitech
- **Ozone**
  - Purotek, Ozonia, Clear Water Tech
- **Hydrodynamic Cavitation (HDC)**
  - VRTX



# **VRTX Technologies**

- **With so many non-chemical devices to choose from, why choose VRTX?**
- **Several independent studies/papers have been presented over the last couple years.**
- **Most suggest VRTX is the leading ncd.**

# Commercial – Industrial Cooling Water Efficiency

PBMP – Cooling Systems By James Reisenberger

Koeller & Company: November 4, 2005

- *“This paper discusses several available technologies that improve the treatment of condenser water, thereby reducing the amount sent to the drain (sewer).”*
- *“We focus on those technologies that have shown the best track record for long-term water efficiency and successful operations.”*
- *“The anticipated system life for the VRTX system is estimated at 20-25 years, approximately the same as the chilled water system that they serve. The weighted average equivalent full load ton-hours for all building types is 1,843 equivalent full load ton-hours. Therefore, the water savings on a 371 ton chilled water system would be 1,843 equivalent full load ton-hours. At 3.0 CoC, this system would consume approximately 5.7 acre-feet of water annually. At 6.0 CoC, the water consumption would drop to approximately 4.5 acre-feet annually. The net water savings would amount to 1.14 acre feet per year for the estimated lifetime of 20 years, 22.8 acre-feet of water.”*

## **“Independent Assessment of the Energy Savings, Environmental Improvements and Water Conservation of Emerging Non-Chemical Water Treatment Technologies”**

- **By:**
- *Michael Gravely, Technical Consultant, California Energy Commission PIER Program*
- *Bruce La Belle, Ph.D. California Environmental Protection Agency*
- *Dr. John Balachandra, California State University at Sacramento*
- **Abstract:**
- *“This paper will discuss the results of a California Energy Commission Public Interest Energy Research (PIER) funded project to complete an independent assessment of the energy savings, environmental improvements and water conservation capabilities of the new and emerging non-chemical water treatment technologies. The project was completed by a team from California State University at Sacramento and included a technical review of several of the emerging technologies and a detailed assessment of two of the emerging non-chemical water treatment technologies. Clearwater Systems Corp. and VRTX Technologies, LLC produced the two technologies assessed.”*
- *“A project advisory committee that included representatives from CalEPA, the Energy Commission PIER Program and local utilities supported this team.”*

# CEC – PIER Project Survey Results

## System in Place

	<u>Dolphin</u>	<u>VRTX</u>
Less Than 1 Year	4	0
Less Than 2 Years	5	2
Greater Than 2 Years	1	5

## Estimated Annual Savings

\$0-\$10K	7	0
\$20K-50K	1	1
\$50K-\$100K	0	1
Over \$100K	0	3
Not Measured	2	2

## Expected Payback

N/A	3	0
0-1 Year	0	1
1-2 Years	3	2
Over 2 Years	4	4

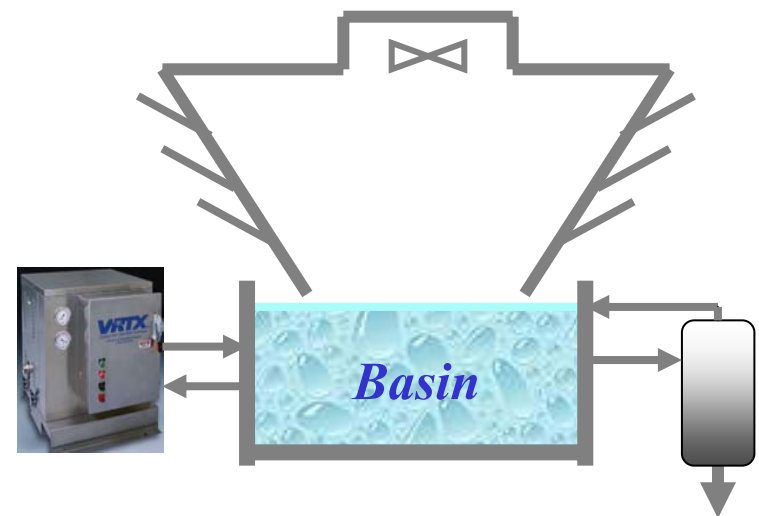
# VRTX Technology

- Patented
- Award winning
- Field-test proven
- Mechanical
- Side-stream treatment
- VRTX unit / filtration unit



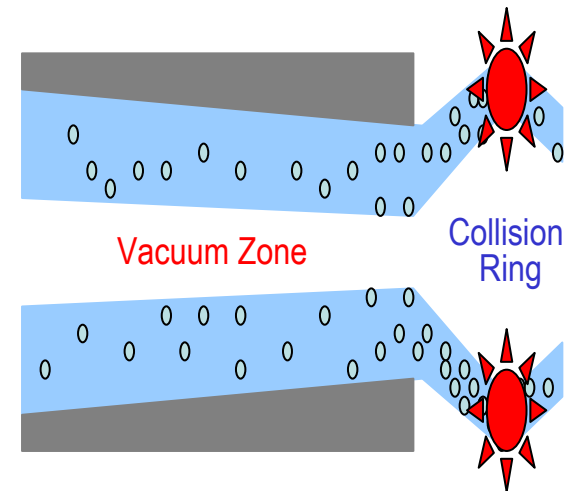
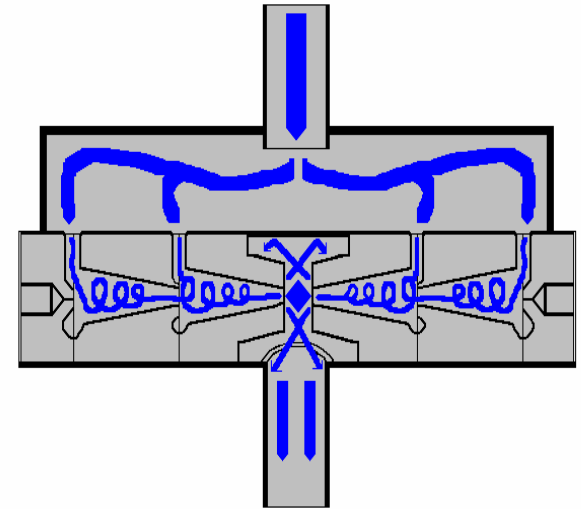
# **VRTX Technology - *How It Works***

- ***VRTX unit and filtration system operate independently***
- ***Both withdraw and return water to sump***
- ***VRTX unit converts dissolved calcium into calcium carbonate colloids, kills bacteria, and removes corrosive gases from water***
- ***Filter system removes suspended solids from recirculating water***



# VRTX Technology - How It Works

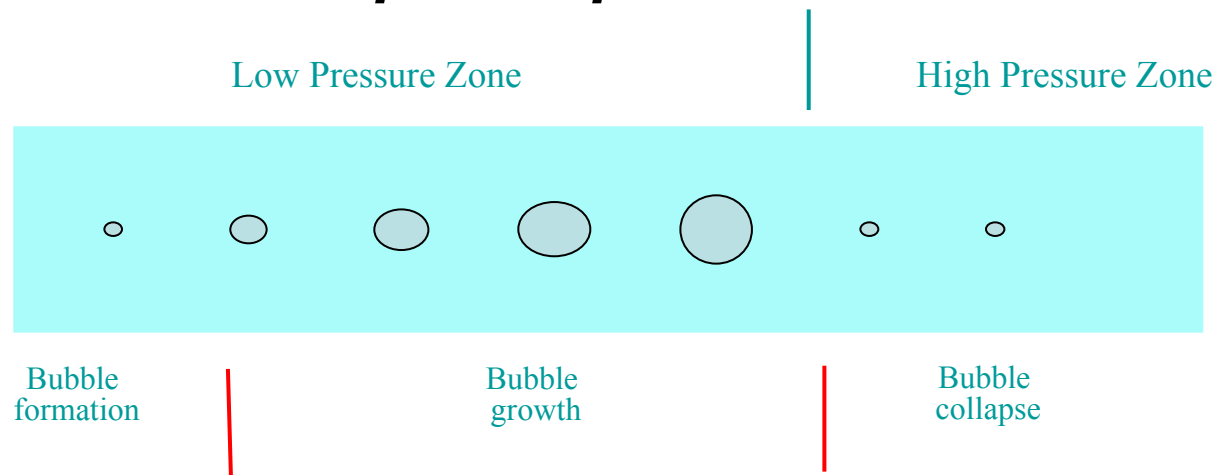
- *VRTX chamber consists of a pressure equalizing chamber and a cavitation chamber*
- *Water is pumped into pressure equalizing chamber, then the water is channeled into the cavitation chamber where it is forced to rotate at high velocity through truncated nozzles*
  - Rotating water streams create strong vacuum
  - Micro bubbles form and grow in the vacuum zone
  - The opposing streams collide at the mid-point of the chamber
  - The bubbles collapse catastrophically when streams collide



# VRTX Technology - *How It Works*

## *Hydrodynamic Cavitation*

- *Produced by pressure variations in a flowing liquid due to the geometry of the system*
- *Cavities are formed when the pressure is lower than a critical value*
- *Cavities grow in low pressure zone*
- *Cavities collapse as pressure increases*

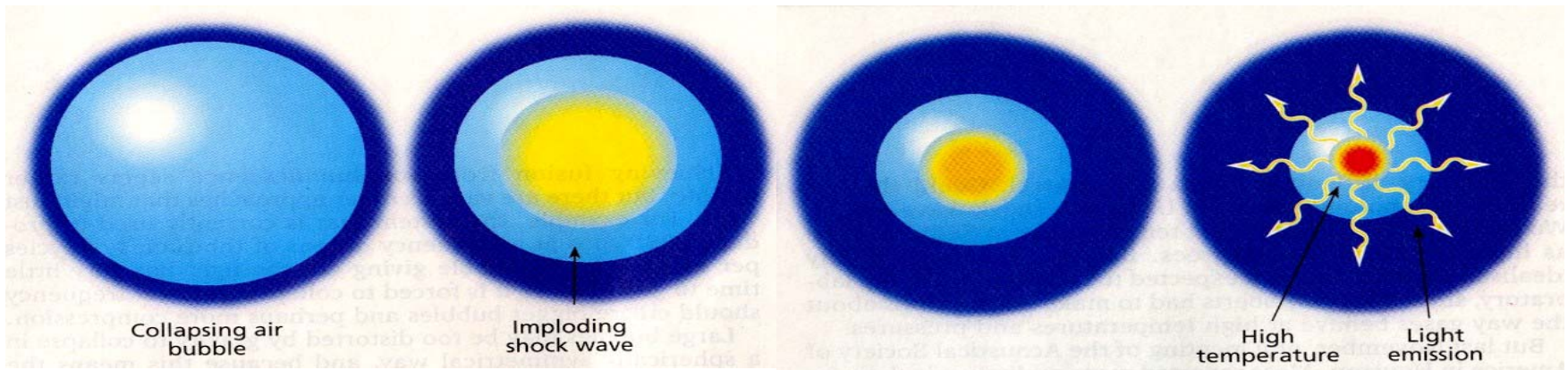




# VRTX Technology - *How It Works*

## *Hydrodynamic Cavitation*

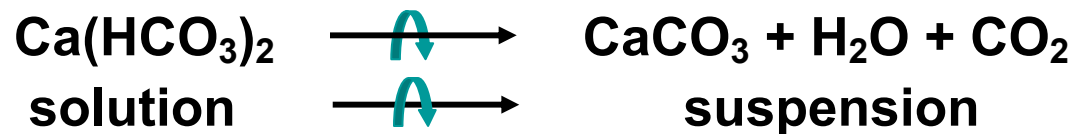
- Cavitation results in
  - High temperature micro-zones
  - High-energy micro-jets
  - Decomposition of water molecules
  - Acceleration of chemical reactions



# VRTX Technology - How It Works

## Chemical reactions

- *Operating conditions force the dissolved calcium and carbonate ions to react and form colloidal, calcium carbonate crystals*

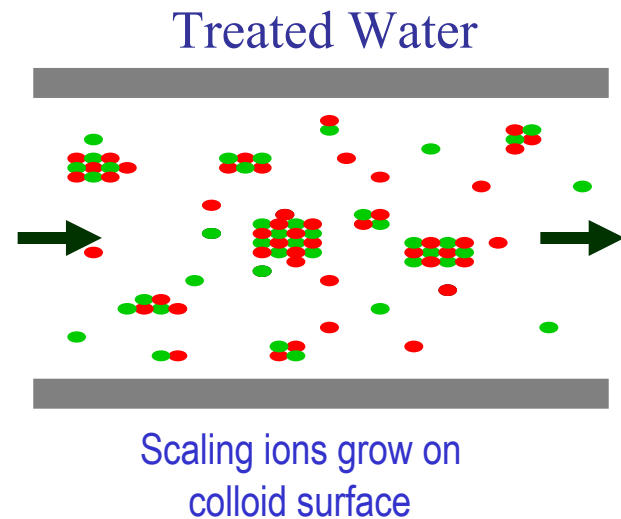
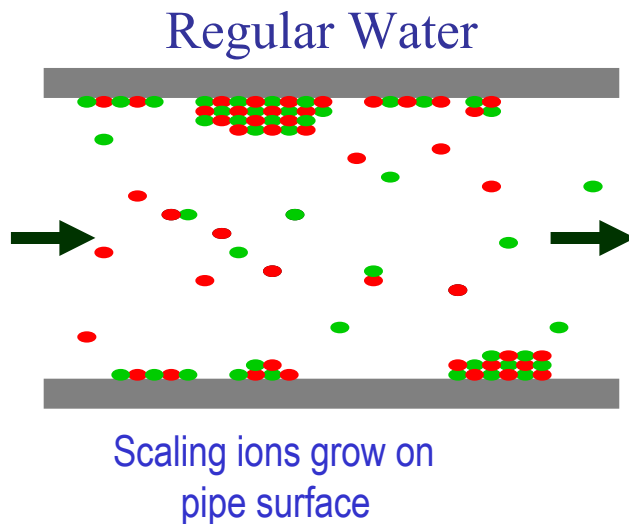


- *Strong vacuum strips CO<sub>2</sub> gas from water and shifts chemical equilibrium to the right*
- *Hydrodynamic cavitation creates extremely high temperature zone; and the solubility of CaCO<sub>3</sub> is decreased*
- *Dissolved calcium and carbonate ions are dehydrated and combine to form CaCO<sub>3</sub>*

# VRTX Technology - *How It Works*

## *Chemical reactions*

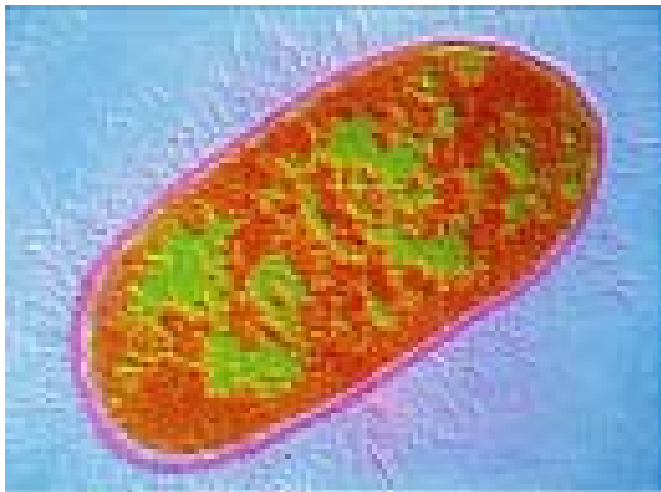
- *$\text{CaCO}_3$  colloids act as incubation sites for dissolved calcium and carbonate ions to grow on*
- *$\text{CaCO}_3$  colloidal crystal grow is thermodynamically favored over precipitation on equipment surfaces*



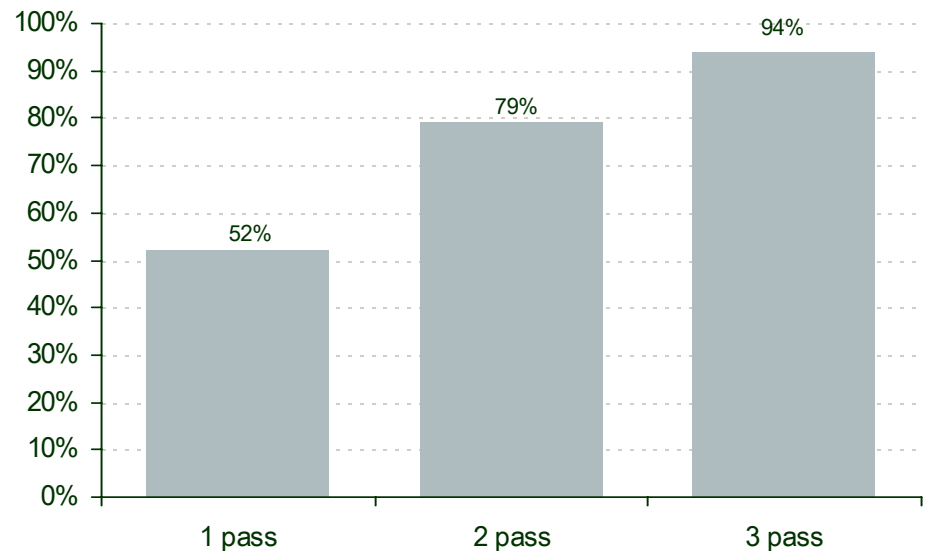
# VRTX Technology - *How It Works*

## *Bacteria Eradication*

- *Dramatic changes in pressure and vacuum*
- *Shear and collision forces created by the collision of water streams*
- *High temperature and sonic waves produced by cavitation*
- *Oxidizing chemicals produced by hydrodynamic cavitation*



Scanning electron micrograph of a bacterium.



# VRTX Technology - *How It Works*

## Sessile, (Slime Forming), Bacterial Control

### Field Test Results on Sessile Bacteria Control International Water Conference Paper IWC-03-22 Comparison of Non Chemical vs. Chemical Treatments

Table 4 – Summary of Sessile Results

Date Removed	PP		Chemical		HDC	
	Cold	Hot	Cold	Hot	Cold	Hot
7/9	$9.5 \times 10^4$		$1 \times 10^3$		$8 \times 10^4$	
8/5	$2.6 \times 10^5$		$4.1 \times 10^5$		$1.8 \times 10^5$	
9/5	$8 \times 10^4$		$2 \times 10^{5**}$		$1.6 \times 10^4$	
9/23	$6.8 \times 10^5$	$1.2 \times 10^5$	$1 \times 10^6$	$9 \times 10^5$	$1.6 \times 10^5$	$1.5 \times 10^5$
10/21	$2 \times 10^6$		$1.1 \times 10^6$		$7.5 \times 10^{5**}$	
10/28	$4.5 \times 10^5$	$1.3 \times 10^4$	$2.1 \times 10^{6**}$	$1.6 \times 10^5$	$1.3 \times 10^5$	$7 \times 10^4$
11/25	$4.5 \times 10^{5**}$		$8.1 \times 10^{6**}$		$1.4 \times 10^5$	
11/25	$1.7 \times 10^7$		$6.8 \times 10^{6**}$		$8.6 \times 10^{4**}$	

Concentration  $< 1 \times 10^6$  =

$1 \times 10^6 < \text{Conc.} < 1 \times 10^7$  =

Concentration  $> 1 \times 10^7$  =

Biofilm Control - **EFFECTIVE**

Biofilm Control - CONSIDER MODIFICATION for IMPROVEMENT

Biofilm Control - IMPROVEMENT REQUIRED

\*\* Sulfate Reducing Bacteria tested positive in these samples

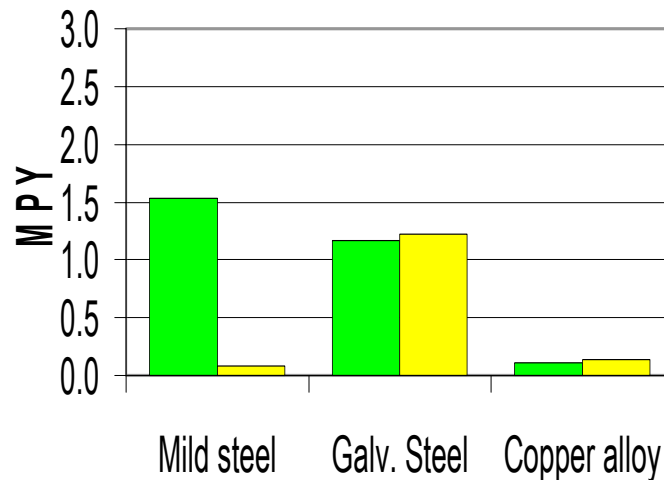
# VRTX Technology - *How It Works*

## Corrosion Control

- *Maintaining water at high pH levels ( $\text{pH} > 8.5$ )*
- *Removing corrosive dissolved gases*
- *Controlling bacterial activity*
- *Eliminating corrosive chemicals*
- *Reducing suspended solids*



Days Exposed: 179



Days Exposed: 127

# VRTX Technology

## *Piping Diagrams*

Evaporative condenser

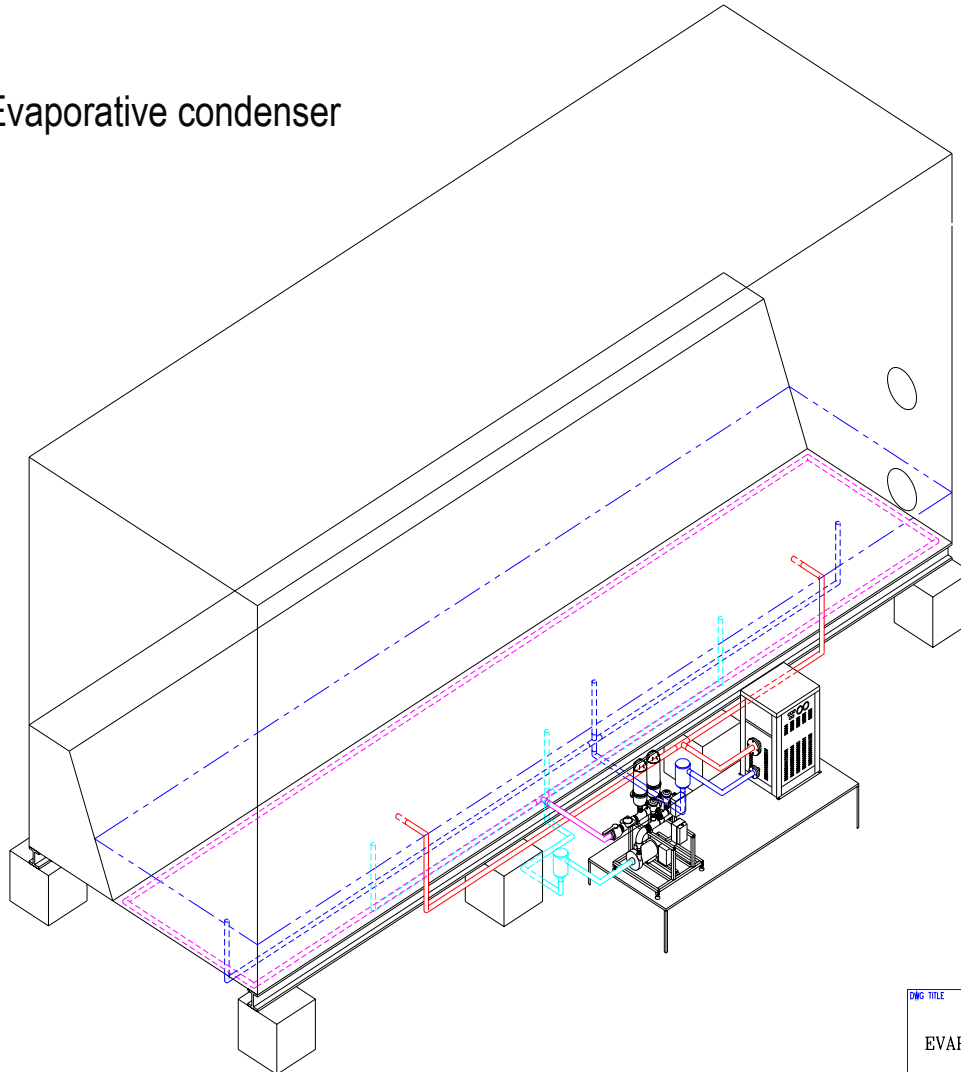


FIG. TITLE

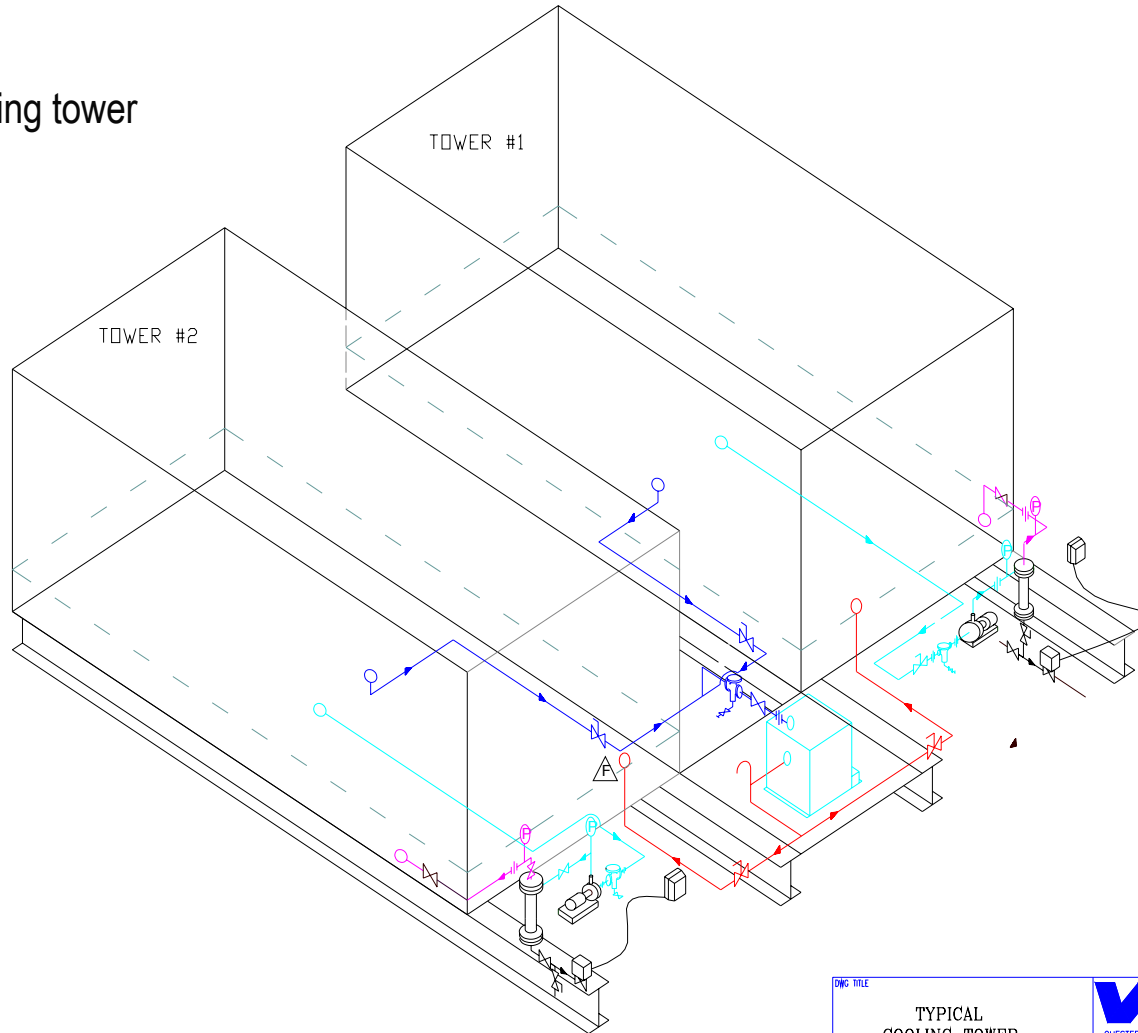
TYPICAL  
EVAPORATIVE CONDENSER

**VRTX**  
CHESTERTON — VRTX TECHNOLOGIES DIV.  
5807 BUSINESS PARK  
SAN ANTONIO, TX 78218

# VRTX Technology

## *Piping Diagrams*

Cooling tower



OWC TITLE

TYPICAL  
COOLING TOWER

**VRTX**  
CHESTERTON - VRTX TECHNOLOGIES DIV.  
5807 BUSINESS PARK  
SAN ANTONIO, TX 78218



# **VRTX Technology**

## ***System Description***

### ***System Components***

- ***VRTX Unit:***  
***VRTX chamber, pump***
- ***Filtration system***
- ***Suction Strainers***
- ***Blow-down control system***



# **VRTX Technology**

- **Awards/Recognition**
- **VRTX Case Histories**



**Plant Engineering  
Gold Medal Award Winner  
February, 1999**

# Winner

## GENERAL MILLS, INC., CHANHASSEN FACILITY

Project name: Mechanical, Chemical-free Treatment of Cooling Tower Water

**Organizations Involved:** General Mills, Inc.; Xcel Energy; Power Process; Minnesota Technical Assistance Program; Metropolitan Council Environmental Services-Industrial Waste Section; State of Minnesota Utilities; Kriss Products; Service Environmental and Engineering; University of Minnesota's EPRI's Food Technology Center; Massachusetts Office of Technical Assistance; Minnesota Waste Wise; Minnesota Department of Agriculture's Agronomy and Plant Protection Division; and A. W. Chesterton

**Award category:** Businesses and manufacturing - Large business

### Program results

- Elimination of toxic and hazardous treatment chemicals (biocides, algacides, and corrosion inhibitors) in the refrigeration cooling tower systems
- Reduced softened water usage to the cooling towers, resulting in reduced softener chemical usage
- An estimated 10% increase in efficiency of ER-1, resulting in a 1.8 million-kilowatt-hour decrease in annual energy usage
- Improved work environment for employees

### Benefits to the environment

40% reduction in water usage (3,674,000 gallons annually) in the evaporative cooling towers, affecting both incoming water and sanitary sewer systems in the plant

### Reductions in emissions related to consuming

1.8 million less kilowatt hours:

- 6,200 pounds of sulfur dioxide
- 5,999 pounds of nitrous oxide
- 400 pounds of particulates
- 2,445,000 pounds of carbon dioxide

### Reductions in annual chemical usage at the

#### Chanhassen facility:

- 620 gallons of chlorine solution
- 1,900 gallons of sulfuric acid and sodium molybdate solution

The General Mills, Inc. (GMD) plant in Chanhassen has two evaporative condenser cooling tower systems to cool the ammonia refrigerant needed for food processing and storage. Water is recirculated from a sump basin to a heat exchanger to remove heat from the refrigerant. Water is sprayed on condenser tubes for cooling the refrigeration approximately 245 days per year. The objective of this project was to reduce or eliminate the chemical treatment of cooling tower water in the plant refrigeration system to reduce chemical emissions to the environment and improve worker safety through reduction of hazardous materials handling.

The search began in 1995 for a system that would eliminate hazardous chemical usage in the plant evaporative condenser towers at the request of a Plant Ammonia Operator during a HazMat training session. The Chanhassen plant inquired about alternative cooling water treatment to replace chemical treatment, but found that none of the non-chemical methods available in the market in the mid-1990s worked

- 3,694 gallons of sodium hydroxide and sodium molybdate solution
- 330 gallons of biocide-microbiocide
- Installation of 21 additional systems across other General Mills plants, resulting in improved environmental conditions in the United States

### Savings

- One-time Service Access Charges (SAC) savings of \$35,000
- Annual savings of approximately \$108,000 at the Chanhassen plant
- Project payback at the Chanhassen facility was less than one year

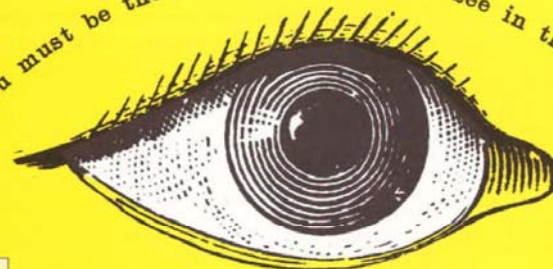
12th  
ANNUAL

# GOVERNOR'S AWARDS

for Excellence in Waste and Pollution Prevention

## 2002 Winners

You must be the change you wish to see in the world.  
— Mahatma Gandhi



PLUS

MnGREAT!  
AWARD WINNERS

October 3rd  
2002

PRESENTED BY THE MINNESOTA OFFICE OF ENVIRONMENTAL ASSISTANCE



**National Registry  
of Environmental Professionals**

***Environmental Award***

**Water, Wastewater, Storm Water Category**



# **2006 AHR Expo Innovation Award Winner**

**Most Innovative Product  
*Green Building Category***

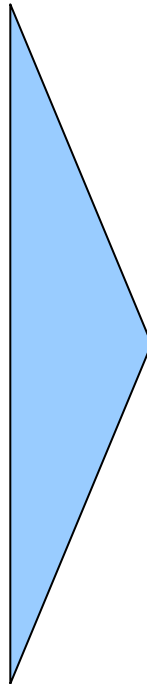


# **VRTX Technology – Case History**

## **Orange Juice Processor**

### **Chemical Treatment**

- New process with 14,000 tons of ammonia refrigeration
- Customer wanted “best available technology”
- Large VRTX system installed in 2002



### **VRTX Treatment**

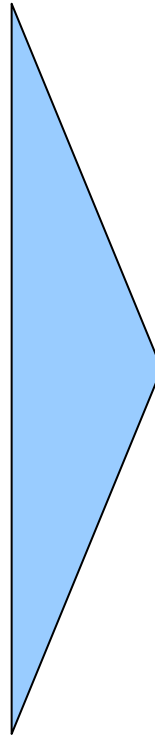
- Eliminated all chemical usage
- Very good corrosion rates
- Increased cycles of concentration to 8
- **Annual water savings of >5 million gallons**
- Controlled bacteria and microbes
- Total net savings of over \$100,000 – payback of 26 mos.
- Little to no scale on heat exchange surfaces

# **VRTX Technology – Case History**

## **Pulp & Paper Company**

### **Chemical Treatment**

- Cycles of concentration 2.5
- Severe corrosion problem in holding tank
- Plant shutdown to clean tank 3x per year
- Bacteria counts of 20,000 CFU/ML



### **VRTX Treatment**

- Cycles of concentration at 7.0
- Corrosion Controlled
- Bacteria counts < 3,000 CFU/ml
- Existing scale removed and no new scale
- **6.2 mm gallons of water saved in first 150 days**
- Makeup savings exceeds 30%
- Blow-down reduction of 80%
- Savings on chemicals, cleaning and maintenance of \$47,000
- Savings on water and sewerage of \$16,000
- Payback period of 14 months



# **VRTX Technology – Case History**

## **Food Processor**

### **Chemical Treatment**

- Softened water used as makeup
- Chemical treatment at a cost of \$22K / yr
- Scale on condenser tubes 3/8 inches and in basin
- Bacteria counts 50,000 – 75,000 CFU / ml
- Cycles of concentration at 3.0
- Discolored water



### **VRTX Treatment**

- Raw city water used as makeup
- Hard scale significantly reduce
- Bacteria counts 5,000 – 10,000 CFU/ml
- Corrosion 1.8 - 2.4 mpy for mild steel
- Cycles of concentration = 8
- **Annual water savings 4.8 million gallons**
- Makeup savings > 30%
- Blow-down reduction >70%



# **VRTX Technology – Case History**

## **Bakery - Evaporative Condensers**

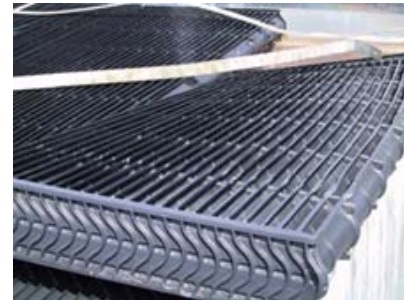
### **Chemical Treatment**

- Annual cost of \$44,500
- Scale, corrosion and bacteria problem
- Cycles of concentration at 2.9
- Customer wanted to eliminate chemicals, lower water costs and improve working environment



### **VRTX Treatment**

- Annual cost savings of \$37,000
- Control of scale, corrosion and bacteria
- Cycles of concentration at  $> 7.0$
- **Annual water savings = 3.76 million gallons**
- Blow-down reduced 75% and makeup reduced 37%
- Energy consumption reduced 10%
- Payback of 12 months
- Additional 14 units purchased



# VRTX Technology – Case History

## Plastic Injection Molding Company – Cooling Towers

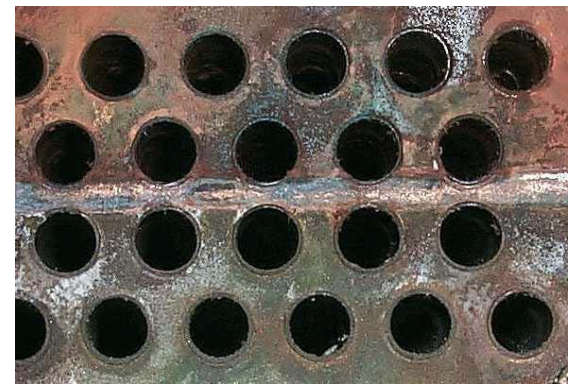
### Chemical Treatment

- Severe scale buildup in heat exchanger tubing
- Heat exchangers and towers need to be cleaned often
- Corrosion and bacteria problem
- Cycles of concentration at  $< 3.0$
- High water usage and hazardous water discharge



### VRTX Treatment

- Control of scale, corrosion and bacteria
- Control of downtime related to water problems
- Cycles of concentration at  $> 7.0$
- Blow-down reduction of 75% and makeup reduction of 37%
- IRR exceeds 25%
- Payback of less than 24 months

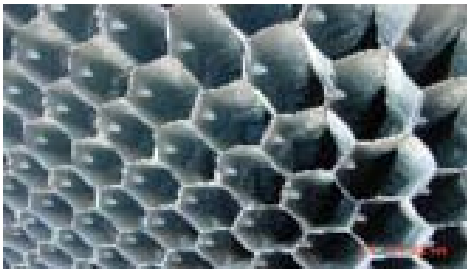


# **VRTX Technology – Case History**

## **Aluminum Company – Cooling Towers**

### **Chemical Treatment**

- Low water quality and unstable water chemistry affecting production
- High bacteria counts 25,000 – 45,000 CFU/ml
- Low cycles of concentration < 3.0
- Company under pressure to reduce water consumption and sewage discharge



### **VRTX Treatment**

- Clean water and clean system
- Stable water chemistry
- Cycles of concentration at 7.0
- Bacteria counts 1,500 – 5,000 CFU/ml
- **Annual water savings of 3.5 million gallons**
- Blow-down reduction of 75% and makeup reduction of 30%
- Total savings of \$36K
- IRR of 18%
- Payback of less than 41 months

#### Water Quality Data

Sample Data	Turbidity	Total Hydrocarbon Content
08/08/01	< 1 NTU	1.1 mg/L
08/23/01	< 1 NTU	1.5 mg/L

# ***Summary***

- ***VRTX System offers a complete solution to cooling water problems – controlling all three problems simultaneously***
- ***Successful treatment of cooling waters with wide range of water chemistries***
- ***Environmentally friendly***
- ***Significant reduction in water consumption***  
Blowdown reductions of 60-80% and 20-30% reduction of makeup common at numerous installations
- ***ROI's range from 12 months to 42 months***
- ***IRR's from 15% to 80%***

# **Leadership in Energy & Environmental Design *LEED* Certification**

## **US Green Building Council**

- *HDC Technology will give significant advantage toward LEED Goal Achievement and Advancement for buildings in pursuit of LEED.*
- *VRTX Awarded 2006 AHR Innovation Award in “Green Buildings” Category*

# Information Needed to Generate a VRTX Proposal

## VRTX TECHNOLOGIES

### QUOTE DATA

#### Data needed for cost justification analysis

- Water cost/100 cubic feet \_\_\_\_\_
- Sewer charge/100 cubic feet \_\_\_\_\_
- Local electric cost/KWH \_\_\_\_\_
- Annual chemical (including biocide) cost \_\_\_\_\_
- Annual cleaning (descaling, etc.) cost \_\_\_\_\_
- Any other associated costs \_\_\_\_\_

#### Data needed for system sizing

- Cooling tower/Condenser tonnage \_\_\_\_\_
- Chiller/Refrigeration tonnage (if any) \_\_\_\_\_
- Cooling tower/Condenser
  - ♦ Make & Model \_\_\_\_\_
  - ♦ Serial number \_\_\_\_\_
  - ♦ Filtration/Separation
  - ♦ Make, Model & GPM \_\_\_\_\_
- System flow rate (GPM) \_\_\_\_\_
- Delta T \_\_\_\_\_
- Total water in system (basin, pipe, reservoirs) \_\_\_\_\_
- Present cycles of concentration \_\_\_\_\_
- Usage (hours/day) \_\_\_\_\_
- Usage (days/year) \_\_\_\_\_
- Estimated Utilization factor (when running) \_\_\_\_\_



# **Bacteria Control with VRTX Technology**



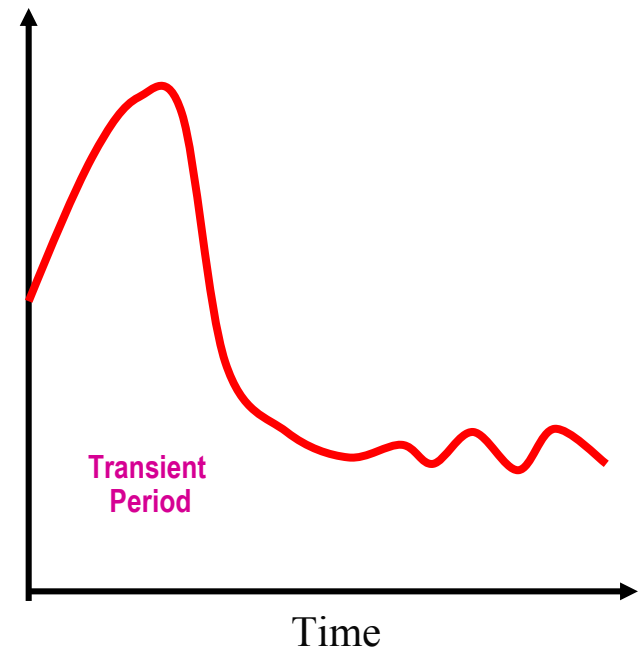
# Bacterial Control

## *How It Works*

- **Physically ruptures cell wall membranes**

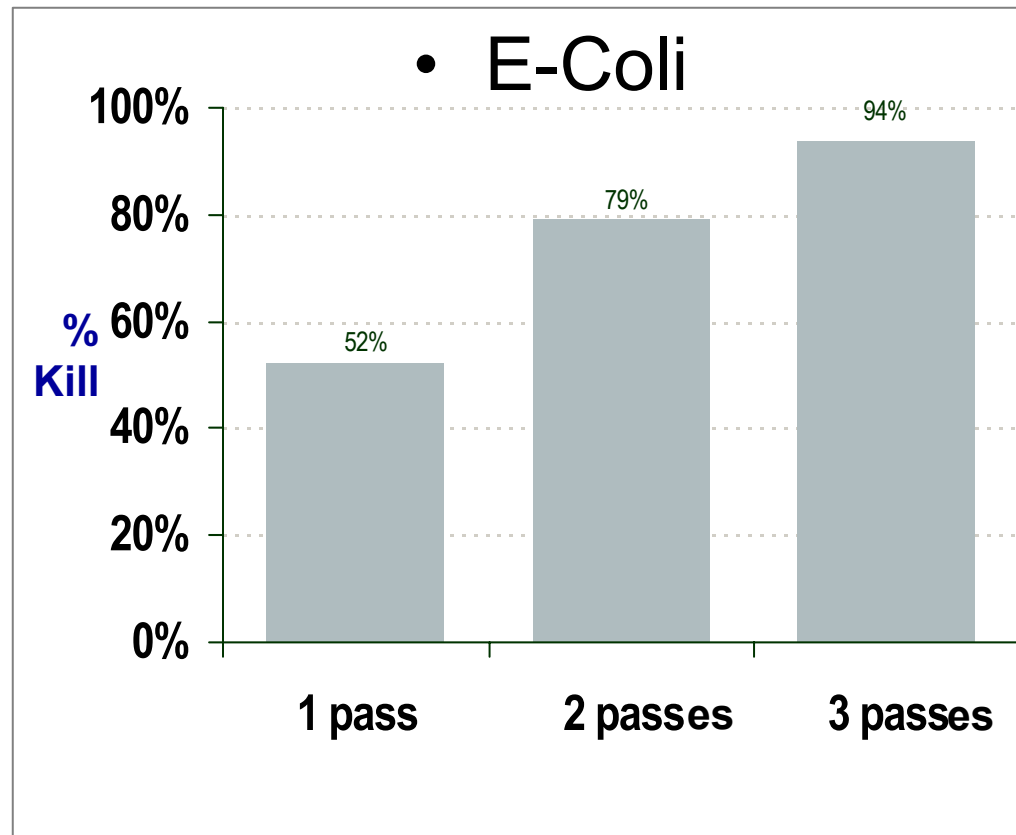
- ✓ Dramatic changes in pressure and vacuum
- ✓ Shear and collision forces created by the collision of water streams
- ✓ High temperature and sonic wave produced by hydrodynamic cavitation

- **A cumulative effect observed in various installations**



# Bacterial Control

## Lab Test Results on Bacteria Kill

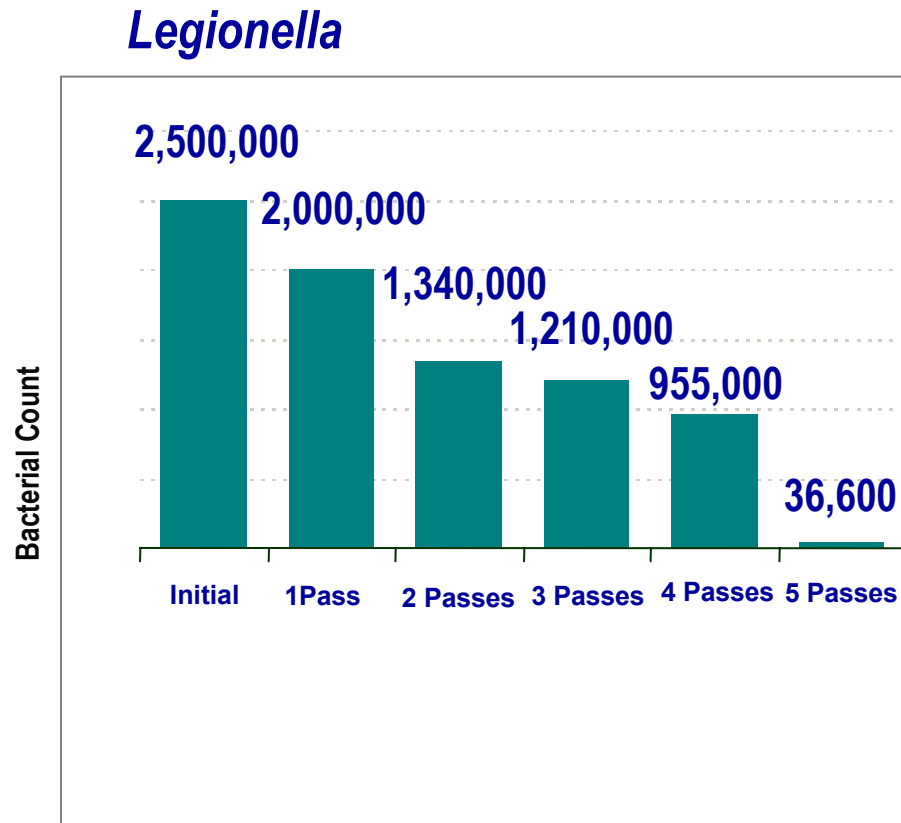


# ***Legionella***

- ***Some Field Data on Legionella***
- ***2 ½ years of “on again/off again” Legionella testing with the Infectious Disease Control Center***
- ***Legionella Test data published October 2003 at the International Water Conference***

# ***Legionella* Control**

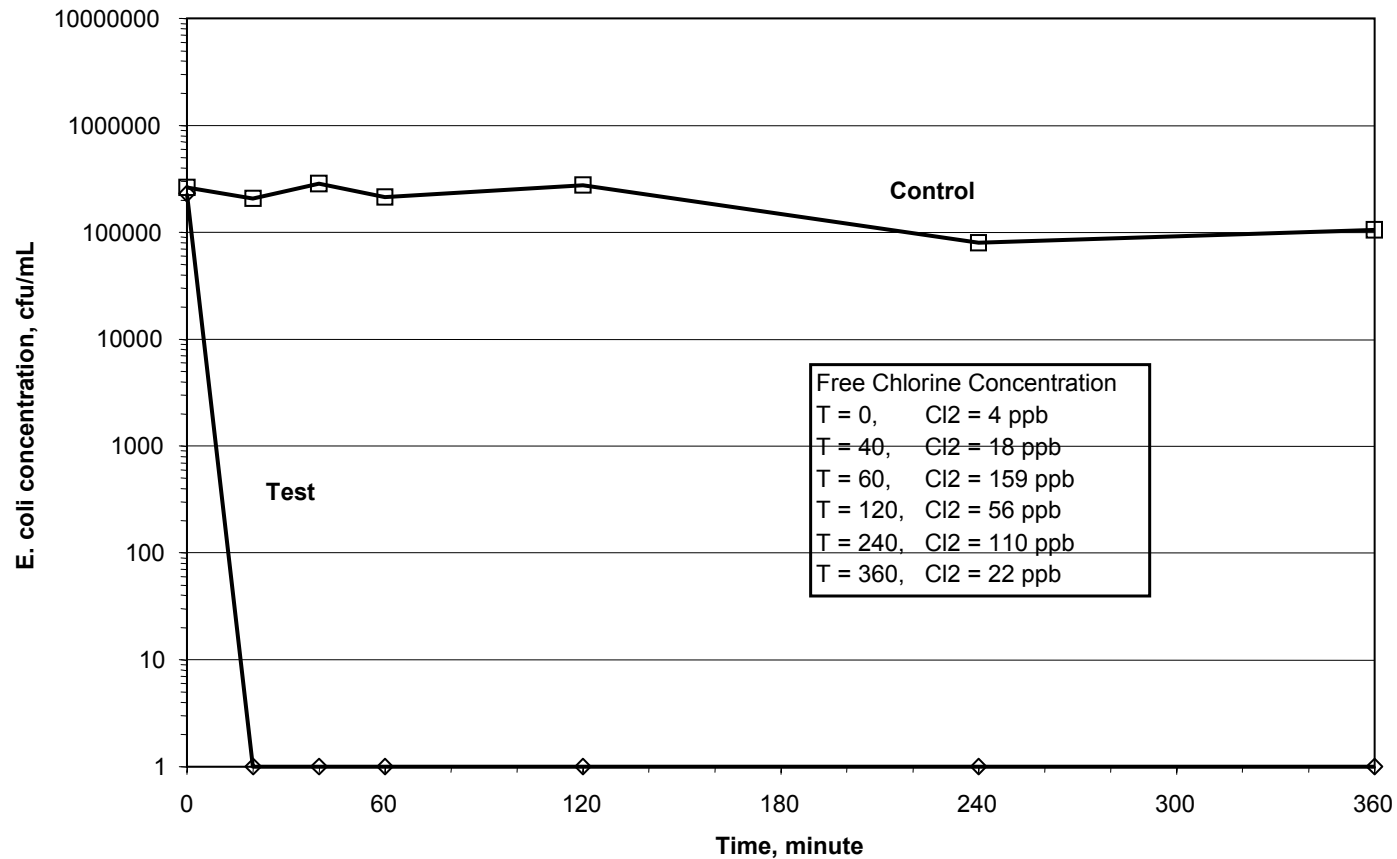
## **Lab Test Results on Bacteria Kill**



# Legionella Control

Figure 1. Efficacy of Device against Laboratory Grown *E coli*  
High Pressure Unit - Sterile Dechlorinated Tap Water

08/21/2002

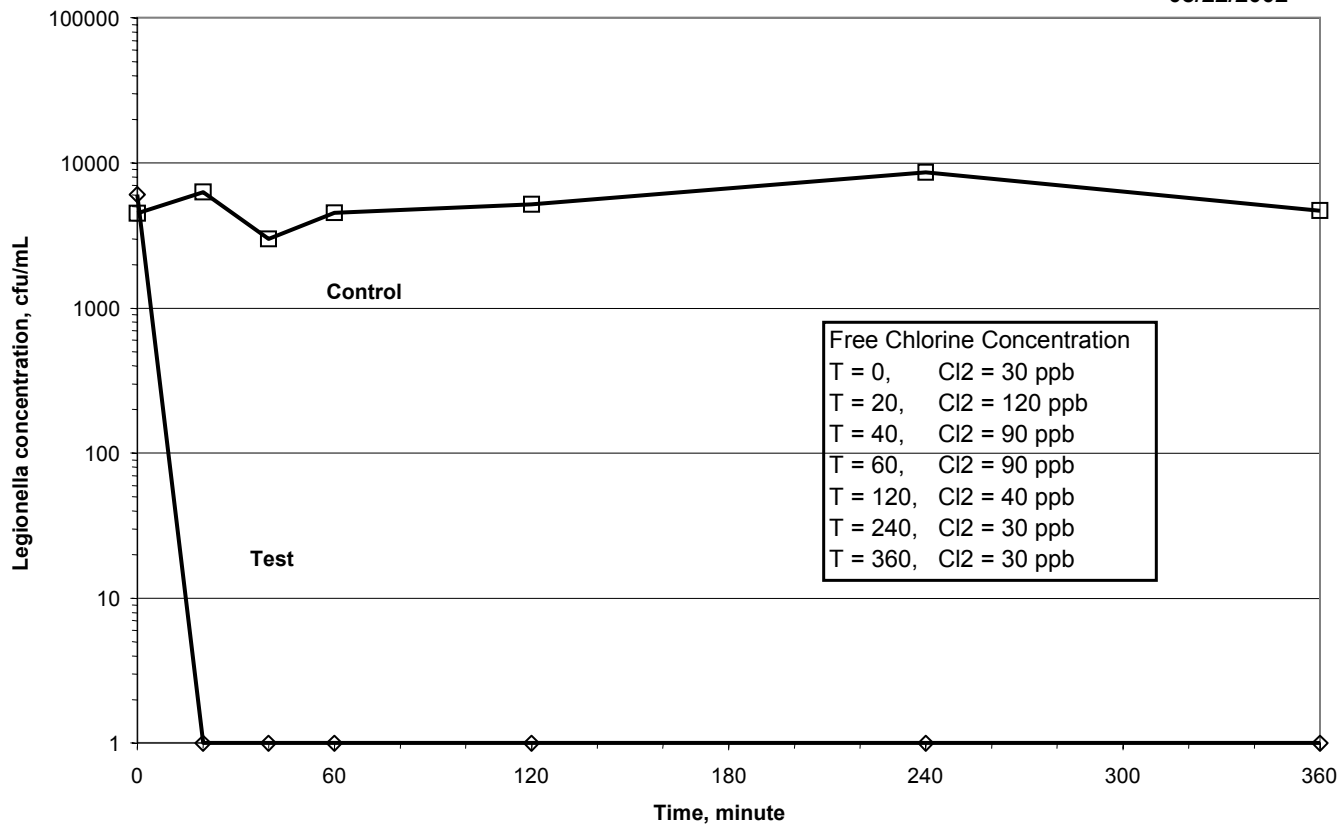


# Legionella Control

Figure 2. Efficacy of Device against Naturally-Grown *Legionella pneumophila* serogroup 1:

High Pressure Unit - Chlorinated Tap Water

08/22/2002



# ***Legionella Control***

## **Customer Report**

- A food manufacturing plant tested every month using the following internal Criteria:
  - < 10 CFU – excellent
  - 1 - 20 CFU – acceptable
  - 20 – 30 CFU – treatment required
  - 30 – 50 CFU – additional treatment required

# ***Legionella Control***

## **Customer Report**

- **Chemical treatment** – Range 10 – 20 CFU;  
approached 50 CFU occasionally
- **VRTX treatment** – 8 – 10 CFU first 2 months;  
reading remained at 0 since

### ***Legionella Test results***

